The Sierra Leone Energy Sector:
Prospects & Challenges

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**Summary**

The policy goal of the energy sector in Sierra Leone is to ensure energy security for sustainable development by providing an enabling environment for the effective and efficient management of the country’s indigenous energy resources.

Such indigenous energy resources of a renewable nature that the attention of the Ministry of Energy and Power is currently focused on include biomass, solar, wind and hydropower.

With respect to biomass, 656,000 tonnes of crop wastes are produced annually, with a total annual energy potential of 2,700 GWh that can be exploited for cooking, lighting and motive power applications.

With an annual solar radiation of between 1460 kWh/m²/yr and 1800 kWh/m²/yr, solar photovoltaic solutions can be implemented in a decentralized configuration across the country for lighting and water pumping, among other applications.

Although countrywide average wind speed is recorded as between 3 m/s and 5 m/s, the Ministry is encouraging further investigation of this renewable resource for an application such as water pumping, which would suit the intermittent nature of this resource.

The hydro potential in the country is recorded in the 1996 Power Sector Master Plan by Lahmeyer International as around 1,200 MW, including capacities above 2 MW. The current Bumbuna project (Phase I capacity 50 MW, total capacity 275 MW) and the envisaged Bekongor project (Bekongor III capacity 85 MW, total capacity 200 MW) are two of the many large projects that are economically exploitable. However, the Master Plan is silent on small capacities under 2 MW. On account of this dearth of data on such small capacities, the Ministry, in collaboration with GTZ, is planning a basic study aimed at gathering hydrological data to feed into the design of small hydro projects with capacities of up to 1 MW. The development of such small hydro projects will lead to rural industrialization and hence employment, poverty reduction and sustainable development.

In the immediate term, however, given the dire power situation in the country, fossil-based generation, utilizing independent power producers, will fast-track the restoration of power and hope to especially Greater Freetown.

Such fossil-based generation is also having support from external donors, namely, the current World Bank Power and Water project, which aims to strengthen the transmission and distribution network in Freetown, the ongoing Moroccan intervention to strengthen the transmission/distribution network as well as improving upon the generating capacity at Kingtom, the 22.68 MW BADEA project, which is expected to be completed by the second quarter of 2008, and the 10 MW JICA project, expected to be completed by the last quarter of 2008.
Background

Institutional Structure

The Ministry of Energy and Power (MEP) is the governmental authority responsible for the electricity and water sectors. The mandate of the MEP includes sector policy formulation, sector planning and coordination.

The electricity sub-sector apart, various other sub-sectors of the wider energy sector of the Sierra Leonean economy fall within the scope of responsibilities of various ministries:

- The MEP handles matters related to electric power supply, including that from hydroelectric schemes and, nominally, renewable energy matters related to solar and wind energy.
- The Ministry of Agriculture and Food Security (MAFS) handles biomass issues (plant- and animal-derived matter), especially fuel wood.
- Petroleum marketing and sales are handled by the Ministry of Trade and Industry (MTI); the Ministry of Finance (MF) also plays a significant role in the import and storage of petroleum products.
- Petroleum exploration and extraction is now within the scope of responsibilities of a Presidential Petroleum Commission.
- The Ministry of Mineral Resources (MMR) deals with extraction of minerals, including energy related minerals.

Legal and Regulatory Framework

The functions of the various ministries and other authorities as they relate to their responsibilities for various energy resources are outlined in relevant Acts of Parliament (accessible via government gazettes) and pertinent regulations. Some of the relevant Acts are listed as follows:

- NPA Act, 1982
- NPA (Amendment) Act, 2006
- Forestry Act, 1998
- Petroleum Exploration and Production Act, 2001

By the NPA (Amendment) Act, 2006, which came into force on March 31, 2005, the monopoly of the National Power Authority over the generation, transmission, supply and other related activities is now repealed.

Accessible Renewable Energy Resources

The Ministry’s current focus is on the following accessible renewable energy resources: biomass, solar, wind and hydropower.

The biomass resource base comprises residues, existing forests and deforested or otherwise degraded lands on which “energy plantations” can be cultivated. Of the residues, 656,400 tonnes of crop wastes (rice husk, rice straw, cocoa husk, etc.) are produced annually, with a total annual energy potential of 2,706 GWh. The existing forests (including primary and secondary forests, savannah and coastal woodlands, and
plantations), experience a total incremental growth of between 9,260 m$^3$ and 15,010 m$^3$ annually. Deforestation is estimated at 3,000 hectares annually.

An estimate of the average annual solar radiation is between 1,460 and 1,800 kWh per square metre per year, but this data stands in need of revision since computations were made from temperature and humidity measurements carried out at only 8 different sites across the country in 1996.

What limited data there is on wind velocities indicate a country-wide average of between 3 and 5 m/s. The Ministry is, however, encouraging studies of sites around the country that may hold potential as economically exploitable resource bases.

Hydropower has been exhaustively researched and documented in the 1996 Power Sector Master Plan. The potential capacity in the country is, according to the Master Plan, estimated at 1,200 MW. The Master Plan, however, is silent on potential resources under 2 MW. On account of this dearth of data on such small capacities, the Ministry, in collaboration with GTZ, is planning a basic study aimed at gathering hydrological data to feed into the design of small hydro projects with capacities of up to 1 MW.

**Energy Policy Goal**

The policy goal of the energy sector in Sierra Leone is to ensure energy security for sustainable development by providing an enabling environment for the effective and efficient management of the country’s indigenous energy resources.

**Issues**

Issues of primary concern in Sierra Leone’s energy sector include:
- Access to improved energy services;
- Energy supply reliability;
- Energy sector governance and regulation;
- Health and environmental costs associated with energy supply and use; and
- Women and energy

**Objectives**

The energy development objectives for Sierra Leone include:
1. To expand access to improved energy services and improve energy supply reliability;
2. To improve energy sector governance and regulation;
3. To reduce the health and environmental costs associated with energy supply and use;
4. To enhance women’s participation in energy policy planning, formulation, implementation and monitoring;

**Strategies**

The following strategies are deemed adequate to address the energy sector objectives highlighted in the foregoing section.
Strategies for Objective 1: To expand access to improved energy services and improve energy supply reliability

- Exploit the country’s hydro potential with particular emphasis on small hydro projects
- Rehabilitate/Restore thermal stations and their associated transmission and distribution networks around the country
- Exploit the country’s renewable energy resource base
- Enhance petroleum exploration activities
- Utilise more LPG (liquefied petroleum gas) in the country
- Ensure availability of petroleum products at all times
- Promote energy efficiency

Strategies for Objective 2: To improve energy sector governance and regulation

- Introduce relevant Acts, Regulations and other measures to improve governance and regulation in the sector

Strategies for Objective 3: To reduce the health and environmental costs associated with energy supply and use

- Ensure the inclusion in Acts and Regulations provisions for pollution abatement from thermal plants and for electricity generation from renewable resources

Strategies for Objectives 4: To enhance women’s participation in energy policy planning, formulation, implementation and monitoring

- Ensure the inclusion in Acts and Regulations provisions that address the issue of women and energy

Envisaged/Existing Actions and Challenges in Addressing Electrical Power Issues

Immediate Term: November 2006 – February 2007

Envisaged/Existing Actions

To provide reliable power for the Western Area in the immediate term, independent power producers (IPPs) must be allowed to generate electricity and sell it in bulk to the National Power Authority (NPA) for subsequent transmission and distribution to consumers. NPA, in addition to its transmission and distribution functions, should continue generating electricity utilizing its current stock of machines, the current state of which is as detailed in the table below:

Table 1: Generating Capacity at Kingtom Power Station (KPS) – November 2006

<table>
<thead>
<tr>
<th>Generator</th>
<th>Year Installed</th>
<th>Installed Capacity [MW]</th>
<th>Available Capacity [MW]</th>
<th>Type of fuel</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mirrlees 2</td>
<td>2006</td>
<td>6.9</td>
<td>6.0</td>
<td>HFO</td>
<td>Undergoing commissioning runs</td>
</tr>
<tr>
<td>Mirrlees 3</td>
<td>2001</td>
<td>6.3</td>
<td>-</td>
<td>HFO</td>
<td>Unavailable due to major breakdown</td>
</tr>
<tr>
<td>Generator</td>
<td>Year Installed</td>
<td>Installed Capacity [MW]</td>
<td>Available Capacity [MW]</td>
<td>Type of fuel</td>
<td>Remark</td>
</tr>
<tr>
<td>-----------</td>
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<td>-------------------------</td>
<td>-------------------------</td>
<td>--------------</td>
<td>--------</td>
</tr>
<tr>
<td>Sulzer 4</td>
<td>1978</td>
<td>9.2</td>
<td>5.5</td>
<td>HFO</td>
<td>Has run for about 35,000 hrs without the usual 9,000-hr routine maintenance</td>
</tr>
<tr>
<td>Sulzer 5</td>
<td>1980</td>
<td>9.2</td>
<td>-</td>
<td>HFO</td>
<td>Undergoing 9,000-hr routine maintenance</td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>1995</td>
<td>5.0</td>
<td>-</td>
<td>HFO</td>
<td>Unavailable due to breakdown</td>
</tr>
<tr>
<td>Caterpillar 1</td>
<td>2001</td>
<td>1.28</td>
<td>-</td>
<td>Diesel</td>
<td>Unavailable due to breakdown</td>
</tr>
<tr>
<td>Caterpillar 2</td>
<td>2001</td>
<td>1.28</td>
<td>0.7</td>
<td>Diesel</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>39.16</td>
<td>12.20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In a bid to take advantage of the IPP option, negotiations have recently been concluded with Aggreko, an established international emergency power supplier, for the generation of 20 MW on a daily basis. The contract for this emergency supply will be for an initial period of 12 months with a renewal option, if deemed necessary. This additional power will be available by the end of January 2007 at the latest. By the end of the immediate term, Greater Freetown is expected to have a steady supply of 30 MW on a daily basis.

**Challenges**

Ongoing theft of overhead and underground cables has greatly hampered the transmission and distribution of electricity in especially the east end of Freetown. The replacement cost of the stolen materials is estimated at US$200,000. The Ministry of Energy & Power and NPA are currently devising a robust action plan involving the Police to address this problem.

In the meantime, thanks to the timely intervention of the Government of Morocco, the Moroccan state-owned electricity utility, ONE, is dispatching a 20-man technical team to Sierra Leone early in November to, among other assignments, address the transmission and distribution network problems.

**Medium Term: 2007 – 2009**

**Envisaged/Existing Actions**
The following activities are envisaged for the medium term:
The Arab Bank for Economic Development in Africa (BADEA) Project (22.68 MW)

Phase I – the supply, installation and commissioning of one 7.56 MW diesel generating unit (DGU) at Blackhall Road to be completed by the fourth quarter of 2007.

Phase II – the supply, installation and commissioning of two 7.56 MW DGUs to be completed by the second quarter of 2008.

The Japan International Cooperation Agency (JICA) Project (10 MW)

The Japanese Government, via JICA, is on course with the implementation of a 10 MW (2 X 5 MW) thermal project at the Kingtom Generating Station by the last quarter of 2008.

The Bumbuna Hydroelectric Project (Phase I: 50 MW)

Ninety-five per cent of the dam construction work has been completed for this initial 50 MW phase. The Government of Sierra Leone has secured a US$10 million loan from the Organization of Petroleum Exporting Countries (OPEC) for the completion of the 161 kV transmission line between Bumbuna and Freetown. The entire first phase of the project is thus expected to be completed by the third quarter of 2007, resulting in a 50 MW generating capacity in the rainy season and 18 MW in the dries.

During this medium term, the Sulzer 5 generating unit (9.2 MW installed capacity) at the Kingtom Generating Station, currently being overhauled, is expected to come on stream with an output of about 6 MW. Thus, by 2009, the minimum expected generation in Greater Freetown will be 100 MW.

Constraints

The inability of Government to provide its own financial contribution to the current phase of the Bumbuna project has necessitated the acquisition of a commercial loan for which a partial risk guarantee (PRG), with its attendant conditionalities, is being provided by the World Bank. The project execution delays that have been experienced thus far are attributable to the need to meet these conditionalities.

Long Term: 2010 – 2015

For a population of about 5 million now, a minimum residential power requirement for the country is 500 MW. Taking population growth and industrialization into account, by 2015 the country should have at least 1000 MW of generating capacity. In an effort to meet this power requirement, the following are some of the initiatives envisaged:

The Bumbuna Hydroelectric Project (Potential: 275 MW)

Phase I – current: 50 MW
Phase II – 40 MW additional installed capacity on the same dam as in Phase I
Phase III – 90 MW additional installed capacity from an additional dam at Yiben, upstream of the current
Phase IV/V - additional installed capacity of 95 MW from both the Bumbuna and Yiben dams

Thus, total installed capacity at the completion of all phases of the project is expected to be 275 MW during the rainy season and 134 MW during the dry season. Phases II to V are estimated to be completed in 5 to 6 years.

The Bekongor Hydroelectric Project (Potential: 200 MW)

In addition to the above hydro project, Government has revived interest in the development of the 85 MW Bekongor III hydro project in the Kono district. In the event of Bekongor I, II and III being developed, an estimated total installed capacity of 200 MW is realizable.

The Bo-Kenema Power Services (BKPS) Goma Hydroelectric Facility (12 MW)

The 4 MW Goma hydroelectric facility operated by the Bo-Kenema Power Services (BKPS), an autonomous subsidiary of NPA, is expected to be expanded to 12 MW in two phases: the first phase is expected to be an upgrade of the turbines from 4 MW to 6 MW and the second the construction of a new dam upstream of the current and the installation of additional turbines to bring the total installed capacity to 12 MW. This upgrade/expansion will be undertaken by the China National Electric Equipment Corporation (CNEEC).

Thus, by 2015, the expected additional total installed generating capacity country-wide is 519.68 MW (487 MW hydro; 32.68 MW thermal), broken down as follows:

<table>
<thead>
<tr>
<th>Generating Facility</th>
<th>Installed Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bumbuna - Hydro</td>
<td>275 MW</td>
</tr>
<tr>
<td>Bekongor - Hydro</td>
<td>200 MW</td>
</tr>
<tr>
<td>Goma – Hydro</td>
<td>12 MW</td>
</tr>
<tr>
<td>BADEA – Thermal</td>
<td>22.68 MW</td>
</tr>
<tr>
<td>JICA – Thermal</td>
<td>10 MW</td>
</tr>
</tbody>
</table>

It has to be noted that the hydro potential in the country, according to the 1996 Lahmeyer International Power Sector Master Plan, is 1,200 MW. Thus, further aggressive exploitation of this energy resource must be relied upon to address the country’s energy problem.

Constraint

The major expected impediment to the exploitation of the country’s hydro potential is funding. However, with the coming into force of the NPA (Amendment) Act, 2006 on March 31, 2005, this funding constraint may very well be addressed by the fact that monopoly of NPA over the generation, transmission, supply and other related activities is now repealed under that Act. Thus, private sector and/or public-private financing of such hydro projects are/is now possible and should be aggressively pursued.
Envisaged/Existing Actions and Challenges in Addressing Rural and Peri-urban Energy Access Needs

Within the context of the ECOWAS “White Paper for a Regional Policy for Increasing Access to Energy Services for Rural and Peri-urban Communities”, adopted on January 12, 2006, a 5-step approach is being adopted by all 15 Member States to ensure access by at least half of their rural and peri-urban communities to modern energy services as a pre-requisite for alleviating poverty and achieving the millennium development goals (MDGs) by the target date of 2015.

The 5 steps include:

i. Launching a multi-sectoral participatory approach;
ii. Creating a vision;
iii. Evaluating needs in terms of energy services;
iv. Developing programmes for increasing access to energy services; and
v. Planning investments and financing

The first two steps having already been executed here in Sierra Leone, by March of 2007 the third step will have been completed and by September 2007 the last two will have been executed, leaving only the execution of the programmes, which will be carried out until 2015. If so required, ECOWAS Secretariat provides technical and/or financial support for executing each of the 5 steps. The Secretariat also serves as a funding source for the actual implementation of the identified programmes.

The energy access goals identified include:

- Cleaner cooking systems;
- Motive power for productive applications at the community level; and
- Electricity for public services

Central to the achievement of the foregoing energy access goals is the utilization of indigenous energy resources of a renewable nature. In that respect, private sector financing or public-private partnerships for the establishment of solar home systems (for lighting, water pumping, etc.), the implementation of biogas digesters (for cooking, lighting and motive power applications), and the establishment of windmills (for lighting, water pumping, etc.) should be vigorously pursued for homes, schools, hospitals, community centres, etc. across the country, now that NPA no longer has monopoly over energy service provision in the country. Even commercial houses and industrial establishments must be encouraged to embark upon this ‘green path’ to sustainable development. And given the hydro potential in the country (1,200 MW), small hydro schemes must be resorted to for far-flung rural communities. The exploitation of such small hydro schemes will lead to rural industrialization and hence employment, poverty reduction and sustainable development.

In Conclusion

To meet the policy goal of achieving energy security for sustainable development, the country’s indigenous renewable energy resources and the associated technologies must be
resorted to for the medium to long term to address the cooking fuel, motive power and electricity needs of the population. Private sector financing or public-private partnerships for the establishment of solar home systems (for lighting, water pumping, etc.), for the implementation of biogas digesters (for cooking, lighting and motive power applications), and for the establishment of windmills (for lighting, water pumping, etc.) should be vigorously pursued for homes, schools, hospitals, community centres, etc. across the country, now that NPA no longer has monopoly over energy service provision in the country. Even commercial houses and industrial establishments must be encouraged to embark upon this ‘green path’ to sustainable development.

This approach is in line with the thinking in the Sub-regional ECOWAS “White Paper for a Regional Policy for Increasing Access to Energy Services for Rural and Peri-urban Populations”, which is geared towards alleviating poverty and achieving the millennium development goals.

Hydro, though a renewable energy resource, can be considered in a category by itself, and a great potential exists in the country for the exploitation of this resource. In addition to Bumbuna and the envisaged Bekongor projects, small hydro projects will lead to rural industrialization and hence employment, poverty reduction and sustainable development. However, considering the dearth of data on small hydro projects under 2 MW capacity in the 1996 Power Sector Master Plan, the basic study that the Ministry, in collaboration with GTZ, is planning aimed at gathering hydrological data to feed into the design of such small hydro projects, should be supported by other donors as well as by the private sector as the necessary first step toward the eventual economic exploitation of the resource.

In the immediate term, however, given the dire power situation in the country, fossil-based generation, utilizing independent power producers, will fast-track the restoration of power and hope to especially Greater Freetown.